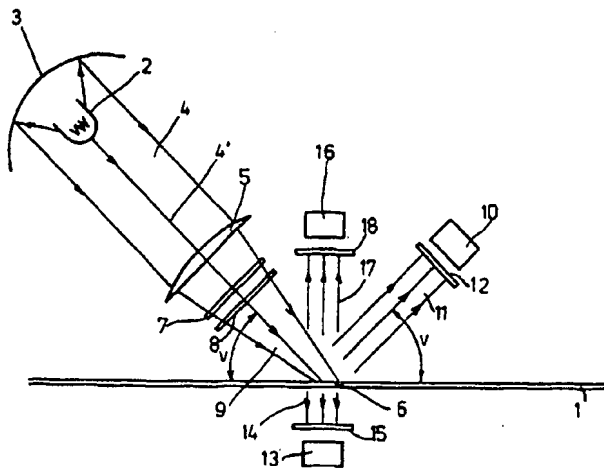




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : G07D 7/00	A1	(11) International Publication Number: WO 97/01155
		(43) International Publication Date: 9 January 1997 (09.01.97)
(21) International Application Number: PCT/DK96/00260 (22) International Filing Date: 18 June 1996 (18.06.96)	(81) Designated States: AU, CA, JP, KR, NO, NZ, PL, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).	
(30) Priority Data: 0699/95 20 June 1995 (20.06.95) DK	Published With international search report. In English translation (filed in Danish).	
(71) Applicant (for all designated States except US): BELLCON I/S [DK/DK]; Svendborgvej 39, DK-8900 Randers (DK).		
(72) Inventor; and		
(75) Inventor/Applicant (for US only): JAKOBSEN, Hugo [DK/DK]; Rensdyrvej 26, DK-8900 Randers (DK).		
(74) Agent: KAJ HANSEN APS . RÅDGIVENDE INGENIØR-FIRMA; Elsegårde Skovvej 5, DK-8400 Ebeltoft (DK).		

(54) Title: METHOD FOR TESTING OF BANK NOTES, ESPECIALLY DOLLAR BILLS, AND EQUIPMENT FOR THE IMPLEMENTATION OF THE METHOD



(57) Abstract

A dollar bill (1) to be tested is illuminated by a pencil of rays (9) of ultraviolet light having an angle of 45°. A first part Φ_1 of the light reflected by the bill and having a wavelength $\lambda < 400$ nm is detected in a photodetecting device (10). A second part Φ_2 of the light passing through the bill and having a wavelength $\lambda = 340$ nm, approximately, is detected in a photodetecting device (13), and a third part Φ_3 of the light emitted from the bill by the effect of fluorescence and having a wavelength in the range $426 < \lambda < 446$ nm is detected in a photodetecting device (16). The three parts of light Φ_1 , Φ_2 , and Φ_3 are compared in an electric circuit to predetermined values referring to a genuine bill. If disagreement exists between at least one of the measured values and the predetermined values, a signal is emitted indicating that the bill is forged. The possible organic differences in the manufacturing material between a tested bill and a genuine bill may be proved with certainty, and thus whether the tested bill is genuine or forged.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgyzstan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SG	Singapore
CH	Switzerland	LI	Liechtenstein	SI	Slovenia
CI	Cote d'Ivoire	LK	Sri Lanka	SK	Slovakia
CM	Cameroon	LR	Liberia	SN	Senegal
CN	China	LT	Lithuania	SZ	Swaziland
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	LV	Latvia	TG	Togo
DE	Germany	MC	Monoaco	TJ	Tajikistan
DK	Denmark	MD	Republic of Moldova	TT	Trinidad and Tobago
EE	Estonia	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	UG	Uganda
FI	Finland	MN	Mongolia	US	United States of America
FR	France	MR	Mauritania	UZ	Uzbekistan
GA	Gabon			VN	Viet Nam

METHOD FOR TESTING OF BANK NOTES, ESPECIALLY DOLLAR BILLS,
AND EQUIPMENT FOR THE IMPLEMENTATION OF THE METHOD

The present invention concerns a method for testing bank notes, especially dollar bills, by which a note to be tested is illuminated by a pencil of light rays from a
5 halogen bulb.

Generally speaking, the American currency has not changed its appearance from 1926 until today. There are only a few safety elements in this currency. It does neither have a watermark nor a safety thread. As a consequence, counterfeiting of
10 this very currency has been extensive through the years and is still increasing. With modern techniques it is presently easy to make dollar-copies of great likeness.

The genuine dollar bill is made from fibres of cotton and flax bonded by polyvinyl alcohol. Forged bills may be made of wood-based fibres or from different combina-
15 tions of textile fibres, which generally deviates from the material structure of the real bill.

From the applicants' Danish patent application no. 1208/94 there is known a method and an apparatus for testing dollar bills. But this method implies a little
20 margin of a few percent where it cannot be decided with certainty whether the bill is genuine or forged.

It is an object of the present invention to provide a method by which it may be decided with certainty whether a dollar bill is genuine or forged. This is attained by
25 a method according to the characterizing part of claim 1.

By this method it is possible to show the organic differences in the manufacturing material between a genuine and a forged dollar bill with greater certainty and thereby to decide with great certainty whether a bill is genuine or forged.

Claim 2 concerns preferred wavelength ranges for the different parts of light used by the method according to the invention.

The present invention also concerns an equipment for the implementation of the
5 method according to the invention.

Claim 3 concerns such an equipment.

Claim 4 concerns a source for ultra-violet light for use in an equipment according to
10 the invention.

Claim 5 concerns an electric circuit, which forms a part of an equipment according to the invention, and claim 6 concerns a signal emitter, which forms a part of an equipment according to the invention.

15

The invention will be described in detail in the following with reference to the drawing, where

Fig. 1 shows in principle an equipment for testing of bank notes by the method
20 according to the invention, and

Fig. 2 shows schematically an electric circuit to be used in an equipment for testing bank notes by the method according to the invention.

25 As shown on Fig. 1 a bank note or bill 1 to be tested is illuminated by a halogen bulb 2, which is placed in the focus of a reflecting mirror 3, whereby a pencil of rays 4 is emitted.

The halogen bulb 2 is situated in relation to the bill 1 so that a center line 4' in the
30 pencil of rays 4 form an angle α , preferably 45° , with the bill 1. Between the

halogen bulb 2 and the bill 1 there is mounted a planoconvex lens 5, that focuses the pencil of rays 4 on a spot 6 on the bill 1. The lens 5 is designed in such a way and/or situated so that the spot 6 has a diameter of about 10° mm. After the lens 5, as seen in the direction of the rays, there is placed a first filter 7 for filtering off infrared light and a second filter 8 for filtering off visible light, so that the pencil of rays 9 hitting the bill consists of ultra-violet or UV-light. A part Φ_1 of the pencil of rays 9 of UV-light hitting a bill is reflected by the bill with an angle v . Another part Φ_2 of the pencil of rays 9 passes through the bill, and a third part Φ_3 is absorbed by the bill.

The portion of UV-light absorbed by the bill material creates a fluorescence-effect in the visible light spectre. This effect varies much as a consequence of the organic composition of the material. Also the presence of non-organic compounds as bleaching agents cause a strongly varied fluorescence effect. The effect of fluorescence may be explained in this way: When organic/non-organic material is hit by UV-photons from the light source, loose electrons are excited away from the atomic nucleus. The electrons, however, quickly return to their original orbits, and by this return they emit light with a longer wavelength. The light is usually recovered in the visible blue-violet range.

The three light parts Φ_1 , Φ_2 , and Φ_3 are measured/registered in the following way.

As shown in Fig. 1 a photodetecting device 10 is placed in such a way over a bill to be tested, so that it is hit by a pencil of rays 11 of light reflected from the bill.

Before the photodetecting device, as seen in the direction of the rays, there is mounted a filter 12, which only allows light with a wavelength of $\lambda < 400$ nm to pass.

Another photodetecting device 13 is situated in such a way under the bill, that it is hit by a pencil of rays 14 of light passing through the bill. Before the photodetecting

device 13, as seen in the direction of the rays, there is mounted a filter 15, which only allows light with a wavelength λ equal to about 340 nm to pass.

5 A third photodetecting device 16 is situated in such a way over the bill, that it is hit by a pencil of rays 17 emitted from the bill by the effect of fluorescence. Before the photodetecting device, as seen in the direction of the rays, there is mounted a filter 18, which only allows light with a wavelength in the range $426 \text{ nm} < \lambda < 446 \text{ nm}$ to pass.

10 As shown on Fig. 2 the three photodetecting devices 10, 13, and 16 form part of an electric circuit, where they are connected to an amplifier each, 19, 20, and 21, respectively. These amplifiers transform the incoming signals up to a desired level, and they are connected to a comparator each, 22, 23, and 24, respectively, in which the incoming signals are compared to a set value, Φ_1' , Φ_2' , and Φ_3' , respectively, 15 whereby there is produced the answer(s) yes/no, over/under, or +/- . The comparators 22, 23, and 24 are connected to a logical circuit 25, which is connected to a signal emitter, which may consist of a first light emitter, for example a green one, that is lit if a tested bill is genuine, and another light emitter 27, for example a red one, that is lit if the tested bill is forged, and of a sound emitting device 28, which 20 emits an audible signal, when a tested bill is forged.

The equipment as shown and described above is only an example of equipment, which may be used for implementing the method according to the invention. Within the scope of the invention other embodiments may be envisioned. For example, the 25 signal emitter may be made in another way.

PATENT CLAIMS

1. A method for testing bank notes, especially dollar bills, by which a bill (1) to be tested is illuminated by a pencil of rays (4) of light from a halogen bulb (2), c h a r
5 a c t e r i z e d in that the bill (1) to be tested is irradiated with ultra-violet or UV-
light, that the pencil of UV-light rays (9) hits the bill at an angle (ν), that preferably
is 45° , that a first part (Φ_1) of the light reflected by the bill (1), a second part (Φ_2) of
the light passing through the bill, and a third part (Φ_3) of the light absorbed by the
bill are registered and compared with a set of predetermined values (Φ_1' , Φ_2' , and
10 Φ_3' , respectively), and that in the case of agreement between the registered values
(Φ) and the predetermined values (Φ') there is emitted a signal indicating that the
bill (1) is genuine, and that in the case of disagreement between at least one of the
registered values (Φ) and the predetermined values (Φ') there is emitted a signal
indicating that the bill is forged.

15 2. A method according to claim 1, c h a r a c t e r i z e d in that the first part (Φ_1)
is filtered and has a wavelength $\lambda < 400$ nm, that the second part (Φ_2) is filtered and
has a wavelength λ approximately equal to 340 nm, and that the third part (Φ_3) is
filtered and has a wavelength in the range $426 < \lambda < 446$ nm.

20 3. An equipment for implementing the method according to claim 1, c h a r a c t e r
i z e d in that the equipment comprises a source of UV-light, that may emit a pencil
of rays (9) against the upper side of a bill (1) to be tested, the rays having an angle
(ν) in relation to the bill; a first photodetecting device (10), that is situated in such a
25 way above the bill, so that the device is hit by a pencil of rays (11) reflected by the
bill (1), and before the photodetecting device (10), as seen in the direction of the
rays, a filter (12); a second photodetecting device (13) that is situated in such a way
under the bill, that the device may be hit by a pencil of rays (14) passing through the
bill, and before the photodetecting device (13), as seen in the direction of the rays, a
30 filter (15); and a third photodetecting device (16), that is situated in such a way

above the bill, so that the device may be hit by a pencil of rays (17), that is emitted from the bill by effect of fluorescence of the part of the rays (9) absorbed by the bill, and before the photodetecting device (16), as seen in the direction of rays, a filter (18); which photodetecting devices (10, 13, and 16) are connected to an
5 electric circuit, that is able to emit a signal indicating whether the tested bill is forged or genuine.

4. An equipment according to claim 3, characterized in that the source of UV-light comprises a halogen bulb (2), a reflecting mirror (3), a planoconvex lens
10 (5), a first filter (7) for filtering off infrared light and second filter (8) for filtering off visible light.

5. An equipment according to claim 3, characterized in that the three photodetecting devices (10, 13 and 16) form a part of an electric circuit where they
15 are connected to an amplifier each (19, 20, and 21, respectively), that transform the signals from the photodetecting devices up to a desired level, which amplifiers are connected to a comparator each (22, 23, and 24, respectively), that compare the incoming signals with a predetermined value, and e.g. emit a "yes/no" signal, which comparators are connected to a logic circuit (25) wherein the incoming signals are
20 processed, and which is connected to a signal emitter.

6. An equipment according to claim 3, characterized in that the signal emitter consists of a light emitter (26), e.g. a green one, that is lit when a tested bill is "good", another light emitter (27), e.g. a red one, that is lit when a bill is "false",
25 and possibly a signal emitter (28) for emitting an audible signal, that is connected to the other light emitter (27).

2 / 2

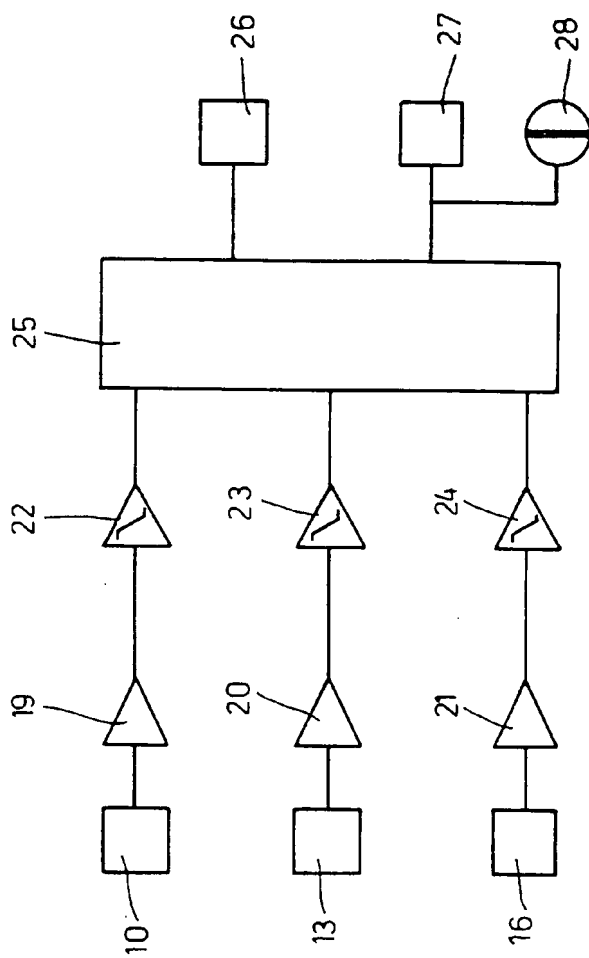


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK 96/00260

A. CLASSIFICATION OF SUBJECT MATTER		
IPC6: G07D 7/00 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
IPC6: G07D		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
SE,DK,FI,NO classes as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9416412 A1 (PRIZEGUARD ASSOCIATES LTD.), 21 July 1994 (21.07.94) --	1-6
A	EP 0537431 A1 (LANDIS & GYR BUSINESS SUPPORT AG), 21 April 1993 (21.04.93) --	1-6
A	SE 455547 B (ARNE BERGSTRÖM), 18 July 1988 (18.07.88) --	1-6
A	SE 454023 B (SODECO-SAIA AG), 21 March 1988 (21.03.88) -- -----	1-6
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
9 October 1996		11.10.96
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86		Authorized officer Per-Olof Warnbo Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT
Information on patent family members

05/09/96

International application No.
PCT/DK 96/00260

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A1- 9416412	21/07/94	AU-B- 663568	12/10/95
		AU-A- 3508593	13/09/93
		AU-A- 5820094	15/08/94
		EP-A- 0626891	07/12/94
		EP-A- 0679279	02/11/95
		JP-T- 7503905	27/04/95
		JP-T- 8505253	04/06/96
EP-A1- 0537431	21/04/93	JP-A- 5282432	29/10/93
		US-A- 5304813	19/04/94
		US-A- 5498879	12/03/96
SE-B- 455547	18/07/88	DE-A,C- 3323313	19/01/84
		GB-A,B- 2122743	18/01/84
		SE-A- 8303525	30/12/83
SE-B- 454023	21/03/88	CH-A- 634411	31/01/83
		DE-A,C- 2924605	17/04/80
		SE-A- 7908324	11/04/80